

CLAIMS

1. A method for estimating residual discharge capacity of a battery for allowing a maximum current to be supplied continuously to a load, said method comprising the steps of:

5 estimating a terminal voltage drop of the battery when a maximum current at high rate discharge is continuously supplied to the load; and
 estimating the residual discharge capacity by subtracting undischARGEABLE charge calculated based on the estimated terminal voltage drop of the battery from dischargeable charge in the battery in any state of charge.

10 2. A method for estimating residual discharge capacity of a battery for allowing a maximum current to be supplied continuously to a load, said method comprising the steps of:

 estimating a maximum terminal voltage drop of the battery when a maximum current at high rate discharge is continuously supplied to the load;
15 calculating a rate of the estimated maximum terminal voltage drop of the battery to a maximum allowable voltage drop of the battery corresponding to the maximum current,
 estimating the residual discharge capacity by subtracting undischARGEABLE charge calculated based on the rate from dischargeable charge
20 in the battery in any state of charge.

3. The method for estimating residual discharge capacity of a battery as claimed in claim 2,

 wherein said maximum voltage drop is a differential voltage between an already known full-charge open circuit voltage of the battery and an end of on-
25 load discharge voltage defined by a limit voltage to supply the maximum current

to the load.

4. The method for estimating residual discharge capacity of a battery as claimed in any one of claims 1 to 3,

5 wherein said estimated voltage drop includes a voltage drop due to a resistance component of the battery estimated at high rate discharge, a voltage drop due to an maximum increased resistance component varied corresponding to the state of charge of the battery estimated at high rate discharge, and a saturated voltage drop due to polarization as a maximum voltage drop due to polarization generated by the maximum current.

10 5. The method for estimating residual discharge capacity of a battery as claimed in claim 4,

wherein said saturated voltage drop due to polarization is estimated as a maximum voltage drop due to polarization corresponding to electric current given by an approximated curve of current-polarization characteristics of the voltage drop due to polarization obtained by removing the voltage due to drop resistance component from an approximated curve of a current-voltage characteristics derived based on data pairs obtained by periodically measuring the discharge current to the load at high rate discharge, and terminal voltages of the battery corresponding to the discharge current.

20 6. A method for estimating residual discharge capacity of a battery for allowing a maximum current to be supplied continuously to a load, said method comprising the steps of:

estimating a maximum terminal voltage drop of the battery when a maximum current at high rate discharge is continuously supplied to the load;
25 and

estimating the residual discharge capacity by subtracting undischargeable charge calculated based on the estimated maximum terminal voltage drop of the battery from dischargeable charge in the battery in any state of charge.

5 7. The method for estimating residual discharge capacity of a battery as claimed in any one of claims 1 to 6,

wherein said residual discharge capacity is revised by multiplying the estimated residual discharge capacity of the battery by a previously calculated rate of residual discharge capacities of deteriorated and undetrriorated batteries.

10 8. An apparatus for estimating residual discharge capacity of a battery for allowing a maximum current to be supplied continuously to a load, said apparatus comprising:

a device for estimating a terminal voltage drop of the battery when a maximum current at high rate discharge is continuously supplied to the load;

15 and

a device for estimating the residual discharge capacity by subtracting undischargeable charge calculated based on the estimated terminal voltage drop of the battery from dischargeable charge in the battery in any state of charge.

20 9. The apparatus for estimating residual discharge capacity of a battery as claimed in claim 8 further comprising:

a device for calculating a rate of said estimated voltage drop to a differential voltage between an end of on-load discharge voltage defined by a limit voltage to supply the maximum current to the load and an already known full-charge open circuit voltage of the battery; and

25 a device for estimating residual discharge capacity by subtracting

charge corresponding to said calculated rate using the end of on-load discharge voltage at high rate discharge from dischargeable charge in the battery in any state of charge.

10. The apparatus for estimating residual discharge capacity of a
5 battery as claimed in claim 8,

wherein said device for estimating a terminal voltage drop includes: a device for estimating a voltage drop due to a resistance component of the battery estimated at high rate discharge; a device for calculating a voltage drop due to an maximum increased resistance component varied corresponding to the state
10 of charge of the battery; and a device for estimating a saturated voltage drop due to polarization as a maximum voltage drop due to polarization generated by the maximum current,

wherein said device for estimating a terminal voltage drop estimates the maximum voltage drop based on voltages calculated or estimated by said
15 respective devices.

11. The apparatus for estimating residual discharge capacity of a battery as claimed in claim 10,

wherein said device for estimating a saturated voltage drop due to polarization estimates the saturated voltage drop due to polarization as a
20 maximum voltage drop due to polarization corresponding to electric current given by an approximated curve of current-polarization characteristics of the voltage drop due to polarization obtained by removing the voltage drop due to resistance component from an approximated curve of a current-voltage characteristics derived based on data pairs obtained by periodically measuring
25 the discharge current to the load at high rate discharge, and terminal voltages of

the battery corresponding to the discharge current.